

21. (Twice Amended) A method of manufacturing a semiconductor device comprising the steps of:

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forming an amorphous semiconductor film on an insulating surface;
providing said semiconductor film with a crystallization promoting material comprising a metal;
crystallizing said semiconductor film by irradiating said amorphous semiconductor film with a pulsed laser beam having a square shape cross section,
wherein said laser beam has a pulse width of 200 nsec or more, and an irradiation area of said pulsed laser beam is 10 cm² or more.

REMARKS

At the outset, the Examiner is thanked for the review and consideration of the present application.

The Examiner's Office Action dated October 4, 2001 has been received and its contents reviewed. By this Amendment claims 2-8 and 20-21 been amended. Accordingly, claims 2-3, 6-13 and 20-23 are pending in the present application, of which claims 2-6, 8 and 20-21 are independent.

Applicant respectfully notes that claim 1 has been canceled in the Amendment dated June 28, 2001, and that the Examiner appears to have inadvertently recited claim 1 as one of the pending claims.

Referring now to the Office Action, claims 1-3, 6-13 and 20-23 are rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Zhang et al. (U.S. Patent No. 5,830,784) in view of Zhang et al. (U.S. Patent No. 5,569,610), Ohtani et al. (JP 9312260A) and Noguchi et al. (U.S. Patent No. 5,869,803). Applicant respectfully traverses the rejection at least for the reasons provided below.

As presented in the Amendment of June 28, 2001, a primary feature of the invention resides in the use of a catalyst, such as nickel, for promoting crystallization of a semiconductor film and the use of a laser beam having a rectangular or square irradiation surface and having a large irradiation area of 10 cm² or more in order to perform the crystallization of a semiconductor film more efficiently.

Further, it is another feature of the invention resides in that an amorphous semiconductor film irradiated with the laser for crystallization, so as to avoid a solid-phase growing method, as

disclosed in the paragraph bridging page 1 and 2 of the specification. Therefore, claims 2-8 and 20-21 have been amended to recite this feature.

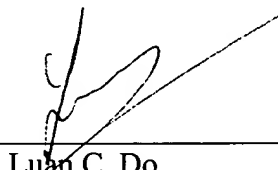
As none of the cited references teach, disclose, or suggest, among other steps, the steps of forming an amorphous semiconductor film and irradiating a laser beam shaped in a rectangle or a square, or whose irradiation area in one shot is 10 cm², to crystallize the amorphous semiconductor film as recited in amended claims 2-8 and 20-21, the combination of the cited references in the § 103(a) rejection would be improper.

In view of the foregoing amendments and arguments, Applicants respectfully request reconsideration and withdrawal of the U.S.C. § 103(a) rejections of claims 2-3, 6-13 and 20-23.

CONCLUSION

Having responded to all rejections set forth in the outstanding non-Final Office Action, it is submitted that claims 2-3, 6-13 and 20-23 are now in condition for allowance. An early and favorable Notice of Allowance is respectfully solicited. In the event that the Examiner is of the opinion that a brief telephone or personal interview will facilitate allowance of one or more of the above claims, the Examiner is courteously requested to contact Applicants' undersigned representative.

Respectfully submitted,

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VERSION OF AMENDED CLAIM WITH
MARKINGS TO SHOW CHANGES MADE

2. (Twice Amended) A method of manufacturing a semiconductor device, comprising:
[a first step of] forming an amorphous semiconductor film;
[a second step of] holding a catalytic element that promotes the crystallization of said semiconductor film in contact with said semiconductor film; and
[a third step of] irradiating a laser beam shaped in a rectangle or a square while moving the laser beam from one side of said amorphous semiconductor film toward another side thereof to sequentially crystallize said amorphous semiconductor film to form a crystalline semiconductor film,
wherein said laser beam has an irradiation area of said pulsed laser beam of 10 cm² or more.

3. (Twice Amended) A method of manufacturing a semiconductor device, comprising:
[a first step of] forming an amorphous semiconductor film [on] over a substrate having an insulating surface;
[a second step of] holding a catalytic element that promotes the crystallization of said semiconductor film in contact with said semiconductor film; and
[a third step of] irradiating a laser beam shaped in a rectangle or a square from one side of said amorphous semiconductor film toward another side thereof while moving said substrate to sequentially crystallize said amorphous semiconductor film to form a crystalline semiconductor film,
wherein said laser beam has an irradiation area of said pulsed laser beam of 10 cm² or more.

4. (Amended) A method of manufacturing a semiconductor device, comprising:
[a first step of] forming an amorphous semiconductor film;
[a second step of] holding a catalytic element contained in a solution which promotes the crystallization of said semiconductor film in contact with said semiconductor film;
and

[a third step of] irradiating a laser beam whose irradiation area in one shot is 10 cm² or more to said amorphous semiconductor film to crystallize said semiconductor film and to form a crystalline semiconductor film.

5. (Amended) A method of manufacturing a semiconductor device, comprising:

[a first step of] forming an amorphous semiconductor film;

[a second step of] holding a compound containing a catalytic element which promotes the crystallization of said semiconductor film in contact with said semiconductor film; and

[a third step of] irradiating a laser beam whose irradiation area in one shot is 10 cm² or more to said amorphous semiconductor film to crystallize said amorphous semiconductor film and to form a crystalline semiconductor film.

6. (Amended) A method of manufacturing a semiconductor device, comprising:

[a first step of] forming an amorphous semiconductor film;

[a second step of] holding a catalytic element which promotes the crystallization of said semiconductor film in contact with said semiconductor film;

[a third step of] irradiating a laser beam whose irradiation area in one shot is 10 cm² or more to said amorphous semiconductor film to crystallize said amorphous semiconductor film and to form a crystalline semiconductor film; and

[a fourth step of] conducting a thermal oxide processing in an oxide atmosphere to form an oxide film on the surface of said crystalline semiconductor film and gettering said catalytic element to said oxide film to remove or reduce said catalytic element existing in said crystalline semiconductor film.

7. (Amended) A method of manufacturing a semiconductor device as claimed in claim 6, further comprising a [fifth] step of removing said oxide film [after said fourth step].

8. (Amended) A method of manufacturing a semiconductor device, comprising:

[a first step of] forming an amorphous semiconductor film;

[a second step of] holding a catalytic element which promotes the crystallization of said semiconductor film in contact with said semiconductor film;

[a third step of] irradiating a laser beam whose irradiation area in one shot is 10 cm² or more to said amorphous semiconductor film to crystallize said amorphous semiconductor film and to form a crystalline semiconductor film; and

[a fourth step of] selectively adding at least one of phosphorus [or] and boron to said crystalline semiconductor film and gettering said catalytic element to said added region by conducting a heat treatment to remove or reduce said catalytic element existing in said crystalline semiconductor film.

20. (Twice Amended). A method of manufacturing a semiconductor device comprising the steps of:

forming a semiconductor film comprising amorphous silicon on an insulating surface;

providing said semiconductor film with a crystallization promoting material comprising a metal;

crystallizing said semiconductor film by irradiating said amorphous semiconductor film with a pulsed laser beam,

wherein said laser beam has a pulse width of 200 nsec or more,

wherein said laser beam has an irradiation area of said pulsed laser beam of 10 cm² or more.

21. (Twice Amended) A method of manufacturing a semiconductor device comprising the steps of:

forming an amorphous semiconductor film on an insulating surface;

providing said semiconductor film with a crystallization promoting material comprising a metal;

crystallizing said semiconductor film by irradiating said amorphous semiconductor film with a pulsed laser beam having a square shape cross section,

wherein said laser beam has a pulse width of 200 nsec or more, and an irradiation area of said pulsed laser beam is 10 cm² or more.